

AMERICAN MUSEUM NOVITATES

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CITY OF NEW YORK APRIL 12, 1949 NUMBER 1415

GEOGRAPHICAL VARIATION IN *ACCIPITER TRIVIRGATUS*

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The Crested Goshawk (*Accipiter trivirgatus*) lives a fairly secretive life in the tropical forest and is therefore not at all common in collections. This is presumably the reason why no revision of the species has heretofore been undertaken. I have gathered a series of 135 specimens with the kind help of the curators of the Museum of Comparative Zoölogy (Cambridge), the Academy of Natural Sciences of Philadelphia, the United States National Museum, the Chicago Natural History Museum, and the Museum of Zoology of the University of Michigan, and including the specimens of the Koelz collection, but even this series is not sufficient to solve all the problems. Much further collecting needs to be done, particularly in Sumatra, Palawan, Formosa, and Nepal.

This revision would have been even more incomplete if it had not been for the splendid cooperation of Dr. K. H. Voous, Jr., who sent me very detailed notes (including full measurements) on 31 specimens (mostly from Malaysia) in the Leiden Museum, the Amsterdam Museum, and in the private collections of F. C. van Heurn and W. C. van Heurn. These notes, for which I am exceedingly grateful to Dr. Voous, have been incorporated in my text.

There are three strikingly different plumages in this species, the adult male plumage, the adult female plumage, and the immature plumage (which appears alike in both sexes). All subspecific characters must be determined by comparing adult males with adult males, adult females with adult females, and immatures with immatures. The number of specimens of each plumage that were examined by me is stated in parentheses in the description given below.

IDENTIFICATION

An adult Crested Goshawk is easy to identify owing to its distinct crest and conspicuous, broad, black line along the center of the throat. Characteristic are also the heavy feet and short middle toes. The inner toe (without claw) reaches the base of the outermost phalanx of the middle toe; the inner toe extends to beyond 60 per cent of the length of the middle toe (without claw). The middle toe is less than 58 per cent of the tarsus. This foot structure separates *trivirgatus* at once from *nisus* and *virgatus*. From *badius* the species is separated by the wing structure, since in *trivirgatus* the sixth primary is longer than the second, while the reverse is true for *badius*. I record these diagnostic characters since I have seen in several collections misidentified specimens in spite of the characteristic features of *trivirgatus*.

GEOGRAPHICAL VARIATION

Pronounced geographical variation is present in regard to both size and coloration. The smallest populations are those found on Nias, Ceylon, and the Philippines, the largest those along the northern edge of the range from northern India to Formosa. The intermediate populations from southern India, Sumatra, Java, Borneo, and Palawan are of approximately identical size.

The proportions are about the same throughout the range of the species. This is evident both in the "tail index" (length of tail in per cent of wing length) and in the "wing tip index" (difference between longest and tenth primary in per cent of total wing length).

TAIL INDEX¹

ADULT MALES: Sumatra, 80.0; Nias, 77.2; Java, 78.2, 78.5, 79.8; Borneo, 73.0, 78.3; Palawan, 79.5, 80.0; Philippines, 74.5, 77.5, 80.2; Ceylon, 79.4; S. India, 78.7; Assam, 81.9, 84.9; N. Burma, 81.9, 82.3; N. Yunnan, 79.3, 82.2; S. Burma, S. Yunnan, N. Siam, Tonkin, 79.3, 80.3, 80.6, 81.8; S. Siam, Tenasserim, Mergui, 77.5, 78.8, 79.3, 79.8, 80.6, 83.4; Hainan, 79.7, 80.5, 80.9, 81.2, 81.4, 81.8, 82.0, 82.4, 82.9, 83.1, 83.3; Formosa, 81.4.

¹ Dr. Voous kindly sent me the following additional figures:

TAIL INDEX

ADULT MALES: Sumatra, 77.6, 77.6, 79.2; Nias, 71.8; Java, 76.1, 76.4, 77.0, 77.2, 77.3; Philippines, 81.3; Ceylon, 81.6.

IMMATURES: Java, 74.4, 76.9, 77.1, 78.5; Borneo, 75.4; Philippines, 81.2; Siam, 77.0; Malacca, 75.9.

IMMATURES: Philippines, 80.6, 81.6; Sumatra, 80.0; Java, 76.1, 77.8; Borneo, 74.6, 75.8, 78.3, 78.7; Palawan, 79.4; Ceylon, 76.0, 82.2; S. India, 77.6, 80, 83.0; S. Siam, 79.3, 80.2, 81.5; Hainan, 77.3, 78.3, 79.6, 80.1, 80.2, 80.3, 80.3, 80.5, 80.5, 81.2; S. Yunnan, N. Indo-China, N. Siam, 80.0, 80.5, 80.5, 81.4; N. Burma, 84.5; Formosa, 79.2; N. India, 82.2.

There is a very slight trend for increase of tail length with increase in latitude.

WING TIP INDEX¹

Philippines, male, 22.9, 24.2, female, 22.6; Nias, male, 23.9, female, 22.9; Ceylon, male, 21.0; Sumatra, male, 21.5, female, 22.4; Java, male, 22.8, 22.9, 23.2, female, 21.7, 23.9; Borneo, male, 19.7, 22.5; female, 19.4, 24.0; Palawan, male, 18.5, 22.1, female, 20.4; S. India, male, 21.7, female, 20.1, 20.7, 20.9, 21.7, 21.7, 22.4, 22.6; S. Siam, Tenasserim, Mergui, male, 18.9, 20.2, 20.9, 21.2, 22.0, 22.1, 22.4, 22.5, 24.0; S. Burma, N. and E. Siam, N. Indo-China, male, 20.7, 20.8, 21.7, 21.8, 22.0, 22.6, female, 20.5, 20.7, 20.8, 22.3, 22.7; Hainan, male, 19.0, 20.4, 21.2, 21.5, 22.1, 22.1, 22.7, 23.0, 23.1, 24.0, female, 18.3, 19.4, 21.0, 21.2, 22.8; N. Burma-N. Yunnan, male, 20.9, 22.7, 24.5, female, 21.8; Formosa, male, 24.5; N. India, male, 20.9, 21.8, female, 19.6, 21.2, 22.1.

The data indicate no geographical variation of the wing tip index. This is not surprising in a species known to be strictly sedentary.

Accipiter trivirgatus

The material available to me permits the recognition of the following 10 geographical races of this species:

Accipiter trivirgatus trivirgatus Temminck

Falco trivirgatus TEMMINCK, 1824, Nouveau recueil de planches coloriées d'oiseaux, livr. 51, pl. 303. Sumatra.

MALE ADULT (1): Blackish crest and crown contrasting with lighter gray sides of head; back brownish, much lighter than crown. Crest well developed; tips of upper tail-coverts white. Breast light tawny rufous; feathers with white edges, particularly on the middle of the breast; cross bars on flanks and abdomen blackish brown; thighs rather lightly barred with black; under tail-coverts pure white.

¹ Dr. Voous kindly sent me the following additional figures:

WING TIP INDEX

Sumatra, male, 19.0, 20.9, female, 21.2, 21.6, 25.0; Nias, male, 23.4, female, 24.0; Java, male, 24.8, 25.3, 25.4, 26.4, 26.9, female, 19.5, 19.7, 23.3, 23.5, 23.6, 23.6, 24.4, 26.1; Borneo, female, 25.1; Philippines, male, 23.3, 29.0, female, 21.7; Ceylon, male, 23.7; Siam, female, 25.3, 30.6; Malacca, male, 23.6.

ADULT FEMALE (1): Like male above but back darker. Streaking of breast earth brown, rather dense, forming a breast shield; abdominal bars broad; thighs heavily barred.

IMMATURE (1): Shaft streaks on crown broad; nape suffused with rufous. Underparts white, slightly washed with rufous on the breast. Streaks on breast feathers diamond shaped, on flanks heart shaped; thighs heavily barred with brownish black.

Wing, male adult, 197, 200, 201, 205; female adult, 218, 218, 221, 221.5; female immature, 210. Tail, male adult, 156, 156, 159, 160; female adult, 160, 170, 174, 174; female immature, 168.

RANGE: Sumatra.

Only one adult male, one adult and one immature female were examined by me. The characters found in this insufficient material were partly confirmed and partly modified by Dr. Voous after an examination of three adult males and three adult females from Sumatra.

***Accipiter trivirgatus niasensis*, new subspecies**

TYPE: A.M.N.H. No. 533323; male adult; Lagundi, Nias Island; December, 1897; Raap (Rothschild Collection).

Smaller and darker than *trivirgatus*.

ADULT MALE (2): Crown sooty black; sides of head sooty gray. Underparts darker than in *trivirgatus*; breast shield extensive and rather earth brown, much more heavily barred on abdomen, flanks, and thigh than *trivirgatus*; bars on thighs broad and very blackish.

ADULT FEMALE (3): Darker than *trivirgatus*; dark bars on abdomen, and flanks broader.

Wing, adult male, 180+, 188, 188; adult female, 207, 209+, 210, 217. Tail, male, 135+, 139, 145; female, 153, 154, 159, 163.

RANGE: Nias Island.

***Accipiter trivirgatus javanicus*, new subspecies**

TYPE: U.S.N.M. No. 218354; male adult; Tjibodas, western Java (4500 ft.); April 18, 1909; O. Bryant.

ADULT MALE (3): Differs from *trivirgatus* by being grayer above, with less contrast between crown, dark gray sides of head and back; crown less blackish and crest shorter. Breast of purer tawny coloration; feathers with little or no white, forming a well-defined breast shield; barring of flanks and thighs a little darker, though matched by one male of *trivirgatus*.

ADULT FEMALE (3): Sides of head darker than in *trivirgatus*;

feathers of breast with much tawny rufous, particularly on sides of breast, not mostly blackish brown as in *trivirgatus*. Two specimens with an almost solid breast shield.

IMMATURE (3): Not clearly distinct from that of Sumatra, pattern of underparts perhaps somewhat coarser.

Wing, male adult, 191, 193, 194, 195, 197, 197, 198, 202; female adult, 208, 209, 215, 217, 217, 225, 226, 230, 230; female immature, 207, 208, 212, 214, 216.5, 218. Tail, male, 150, 150, 150, 151, 152, 153, 154, 155; female adult, 154, 157, 162, 164, 166, 168, 172, 180, 188; female immature, 154, 159, 165, 165, 168, 168.

RANGE: Java.

***Accipiter trivirgatus microstictus*, new subspecies**

TYPE: A.M.N.H. No. 447450; female immature; Riam, south-west Borneo; November 7, 1935; J. J. Menden.

ADULT MALE (3): Crown gray black, crest long. Very light underneath; middle of breast with much white; tawny rufous breast shield reduced to two patches on sides of breast; barring of abdomen and flanks narrow, of thighs very narrow.

ADULT FEMALE (5): Variable. Averages lighter below than *trivirgatus*, with a less pronounced breast shield, broader white bars on abdomen and flanks, and finer barring on the thighs.

IMMATURE (5): Purer white underneath, with the size and number of dark spots much reduced. Spots on breast narrow, streak shaped, well defined; spots on flanks broader. Strikingly different from immature *trivirgatus*.

Wing, male adult, 191+, 198, 200; male immature, 181.5, 189; female adult, 216, 217+, 218, 225, 227; female immature, 203, 209, 210, 211. Tail, male adult, 146, 154, 155; male immature, 137+, 148; female adult, 159, 163, 165, 165, 178; female immature, 156, 159, 159, 160.

RANGE: Borneo.

***Accipiter trivirgatus palawanus*, new subspecies**

TYPE: A.M.N.H. No. 533335; female immature; Taguso, Palawan; September 14, 1887; Whitehead.

ADULT MALE (2): Very similar to *microstictus*, but more heavily marked underneath; rufous breast shield more extensive and of a deeper, more earthy brown; abdomen, flanks, and thighs more coarsely barred; bars on abdomen purer black.

ADULT FEMALE (2): Like *microstictus*, but spotting and barring

of underparts reduced. Breast with drop-shaped dark spots, sides of breast walnut brown. White bars on flanks and thighs wider. One south Borneo bird almost indistinguishable.

IMMATURE FEMALE (1): Strikingly different from *microstictus* by being tawny buff below, almost without markings. There are only a few narrow shaft streaks on the sides of the breast, a few spots on the flanks, and narrow, partly interrupted bars on the thighs. Crown tawny rufous with the black mark on each feather rather small.

Wing, male, 189, 195; female adult, 218.5, 220.5; female immature, 204. Tail, male, 151, 155; female adult, 169, 177; female immature, 162. Relative length of tail greater: 77.3, 79.4, 79.5, 80.0, 80.1, against 73.0, 73.0, 73.2, 74.6, 74.8, 75.8, 76.3, 78.3, 78.3, 78.3, 78.7 in Borneo birds.

RANGE: Palawan, Calamianes, Natuna Islands (?).

I pointed out earlier (1945, *Zoologica*, vol. 30, p. 106) that Palawan birds might constitute an endemic race. Dr. A. Rand, comparing recently collected Palawan material of the Philippine Expedition of the Chicago Natural History Museum with specimens from the Philippines, found that they were strikingly different. Knowing that I was working on this species, he generously sent me his notes and material. Actually the Palawan population is close to that from Borneo and differs from it strikingly only in the immature plumage.

A single immature female from Natuna (wing 207) is intermediate between *microstictus* and *palawanus* in the reduction of streaking underneath.

***Accipiter trivirgatus extimus* Mayr**

Accipiter trivirgatus extimus MAYR, 1945, *Zoologica*, vol. 30, p. 106. Mindanao, Philippine Islands.

Nearest to *microstictus* (Borneo).

ADULT MALE (4): Very light and rufous underneath. Breast shield fairly extensive; mixed with some white, but not so much as in *microstictus*. Barring of abdomen and flanks more or less rufous, strongly contrasting with black barring of thighs. Crown gray, crest short, back with a considerable suffusion of gray in fresh plumage. Differs from *trivirgatus* by the pure rufous breast shield, rufous bars on the abdomen and narrower white bars on the thighs; crown lighter gray and crest shorter. Upper tail-coverts in all plumages without white tips.

ADULT FEMALE (2): Differs from *microstictus* and *trivirgatus* by the very rufous breast, almost as in the male, and by the rufous barring of abdomen and flanks. Thighs more finely barred with white and dark brown.

IMMATURE (2): Very distinct. More heavily marked than *microstictus*; streaks broader, ill defined, and more rufous, some with narrow black shaft streaks. Thighs densely covered with narrow blackish and white bars. Differs from *trivirgatus* by the streaked rather than spotlike pattern underneath, and by the smaller size of the marks; feathers of back without pale edges.

Wing, male adult, 182, 187, 188, 191+, 193; male immature, 186, female adult, 205, 208, 217; female immature, 213. Tail, male adult, 140, 141, 148+, 150; male immature, 150, 151; female adult, 157, 164.5, 167; female immature, 174. (All measured birds are from Mindanao, except the two in italics.)

RANGE: Negros, Samar, Leyte, and Mindanao.

A male and a female from Samar (measurements in italics) average somewhat larger and darker than Mindanao birds. I have not seen any Negros material.

The Philippine subspecies is obviously derived from the Bornean one. This is indicated not only by its characters, but also by its range in the southern Philippines. It has nothing to do with continental *indicus*, as believed by Van Marle and Voous (1946).

***Accipiter trivirgatus layardi* Whistler**

Astur trivirgatus layardi WHISTLER, 1936, Jour. Bombay Nat. Hist. Soc., vol. 38, p. 434.

ADULT MALE (1): Similar to *peninsulae*, but sides of breast more tawny rufous, less earth brown; breast shield more extensive; bars on abdomen and flanks broader and more mixed rufous, less blackish; thighs much more heavily barred. Underwing more heavily spotted. Very similar to *trivirgatus*, but slightly smaller; crown more brownish, sides of head darker; pattern of underparts darker.

ADULT FEMALE: None examined.

IMMATURE (3): Underparts strongly washed with tawny ocher; pattern reduced; spots longitudinal, streaklike, not heart-shaped as in *trivirgatus*.

Wing, male adult, 190, 190, [183, 184]; male immature, 184; female adult, [199–206]; female immature, 199.5. Tail, male adult, 151, 155, [150, 152]; male immature, 140, 145; female adult,

[157-168]; female immature, 164. (Measurements from Whistler, 1936, in brackets.)

RANGE: Ceylon.

The differences found by me between a single male from Ceylon and a single male from Londa (Bombay) are almost exactly opposite to those given by Whistler (*loc. cit.*) who states that "Cinghalese birds differ from those of s. w. India in the much deeper, more chocolate brown of the markings on the breast, flanks, and upper abdomen in the adult. These markings are smaller in extent and pear-shaped in character, so that the breast gives an impression of white, spotted with dark brown. In the continental birds, on the other hand, the impression is more of a brown breast with the feathers edged with white." However, this diagnosis appears to have been based largely on females. Whatever its color characters are, the Ceylon form is well characterized by its small size.

***Accipiter trivirgatus peninsulae* Koelz**

Accipiter trivirgatus peninsulae KOELZ, 1949, Auk, vol. 66, p. 83. Londa, Bombay district, peninsular India.

ADULT MALE (1): Similar to *trivirgatus*, but pattern underneath darker, more blackish brown; size of dark spots and stripes reduced; breast shield earth brown, reduced in size and mixed with much white; amount of barring on abdomen and thighs reduced, bars blackish.

ADULT FEMALE (8): Very similar to *trivirgatus*, but with reduced pattern underneath which averages darker, more blackish brown.

IMMATURE (3): Somewhat intermediate between *layardi* and *trivirgatus*, but more heavily spotted than either. The spots are blackish brown and larger than in *layardi*; they are drop-shaped on abdomen and flanks, not heart-shaped as in *trivirgatus*; the ground color is whitish.

Wing, male adult, 203; male immature, 211; female adult, 215, 224, 227, 228, 228, 235, 237; female immature, 228, 230. Tail, male adult, 160; male immature, 169; female adult, 171, 175, 175, 176, 178, 178, 182, 194.

RANGE: Southern India, approximately south of a line from Bombay to the mouth of the Krishna River.

***Accipiter trivirgatus indicus* Hodgson**

Astur indicus HODGSON, 1836 (Oct.), Bengal Sporting Magazine, vol. 8, p. 177. Nepal.

Spizaetus rufitinctus HORSFIELD, 1839, Proc. Zool. Soc. London, p. 153. Banks of the Brahmaputra, Assam.

ADULT MALE (2): Differs from *trivirgatus* by being very dark above, with blackish crown and short crest. Breast shield brownish rufous, rather extensive; barring of abdomen narrow and rather rufous; thighs strongly barred; under wing-coverts heavily marked. Breast more rufous than in *peninsulae*.

ADULT FEMALE (3): Darker above and lighter below than *peninsulae*. Crown very blackish. Striping and barring of underparts reduced; no pronounced breast shield developed because brown stripes on breast are rather narrow; bars on abdomen and flanks brownish and rather faded.

IMMATURE (3): Rather strongly washed with buffy rufous underneath. Streaks on breast narrow, on abdomen and flanks broader, but rather diffuse; barring of thighs not well defined.

Size large. Wing, male adult, 229.5, 229.5; male immature, 219; female adult, 254, 255, 260. Tail, male adult, 188, 195; male immature, 180; female adult, 200, 205, 213 (north Indian specimens).

RANGE: Northern India, south about to the Godavari River, Assam, the Indo-Chinese countries, Hainan, and Malay Peninsula.

The above given diagnosis is based on specimens from Sikkim, Cachar, and Assam. Specimens from the type locality, Nepal, were not available for examination.

Specimens from the Indo-Chinese countries appear not to be quite typical but are better not separated subspecifically. They are somewhat intermediate between the Indian and the Formosan subspecies. The series from these localities show more individual variability than is usual in this species.

A series of 16 adult males from Burma, western Yunnan, Indo-China, northern and peninsular Siam, and Mergui Archipelago shows no definite geographical trend. There may be a well-developed, almost solid breast shield, or the breast is largely white with oval streaks; these streaks may be rufous, or more often grayish vinaceous. The thighs may be heavily or lightly barred. The barring on abdomen and flanks is usually rather light, matching the breast fairly well or slightly darker.

Thirteen adult females from northern India and the Indo-Chinese countries show no clear-cut trends of geographical variation; this includes females from Sikkim (1), Assam (2), northern Burma (1), Shan States (1), northern Siam (2), eastern

Siam (3), peninsular Siam (2), and Mergui Archipelago (1).

Seven immatures from Burma, Siam, and Indo-China appear conspicuously different from three immatures from Assam. The ground color is white, not heavily suffused with buffy rufous; the stripes are blacker, narrower, and better defined. However, a single chick from Indo-China seems to have the characters of the Assam birds, and a specimen from Mengtz, Yunnan, appears somewhat intermediate. A larger series of immatures from India needs to be examined to establish the constancy of this difference.

HAINAN: A series of 11 adult males is very variable, but the breast is much variegated with white, and the amount of rufous is reduced. The streaks on the breast are usually rather dark. Adult females (5) fall well within the range of variation of a series of Siam females. There is no solid breast shield, the breast is variegated with much white, and the pattern is rather blackish brown. A series of immatures (11) is rather whitish below and varies from strong spotting to practically no spotting at all; the spots are rather narrow and blackish brown.

NORTHERN BURMA, NORTHERN YUNNAN: Wing, male adult, 225, 233, 235, 236; male immature, 233. Tail, male adult, 185, 187, 191, 193; male immature, 197.

SOUTHERN BURMA, SOUTHERN YUNNAN, NORTHERN SIAM, TONKIN: 220, 221, 228, 237; female adult, 253, 255, 264; female immature, 251, 270. Tail, male adult, 177.5, 180, 181, 191; female adult, 201, 206, 209; female immature, 202, 220.

EASTERN SIAM, LAOS: Wing, male adult, 216; male immature, 221, 230; female adult, 247, 261; female immature, 248.5, 255. Tail, male adult, 168; male immature, 178, 184.5; female adult, 204; female immature, 199, 204.

SOUTHERN SIAM, TENASSERIM, MERGUI: Wing, male adult, 217, 219, 219, 226, 227, 227; male immature, 211; female adult, 232, 235, 246, 253; female immature, 246. Tail, male adult, 170, 175, 179, 180, 181, 182; male immature, 172; female adult, 182, 186.5, 191, 191; female immature, 195.

HAINAN: Wing, male adult, 217-236 (227.0); male immature, 223, 224, 226, 226; female adult, 248, 254, 260, 262, 262; female immature, 246-265 (254.0). Tail, male adult, 179-193 (185.6); male immature, 180-182; female adult, 196, 206, 209, 212, 213; female immature, 195-211 (200.6).

MALAY PENINSULA: Wing, male immature, 203. Tail, male immature, 154.

There is an obvious decrease of size from north to south, the minimum size being reached on the Malay Peninsula (also *vide* Chasen). However, it seems inadvisable to recognize any races in view of the gradual change of size as well as the wide range of size variation of the Hainan population. The population from the Malay Peninsula, in particular, requires further study. It might actually be closer to nominate *trivirgatus*.

Accipiter trivirgatus formosae, new subspecies

TYPE: A.M.N.H. No. 533319; female immature; Tapposha, Formosa; January 21, 1907; Alan Owston.

ADULT MALE (1): Very dark, particularly below. Brown spots on breast with blackish margins and blackish shaft streaks; brown bars on abdomen and flanks bordered with blackish; under wing-coverts with blackish bars.

IMMATURE FEMALE (1): Very dark and heavily marked underneath; breast with broad, blackish brown, drop-shaped spots; feathers of flanks with broad brown bars; thighs heavily barred.

Wing, male adult, 233; female immature, 255. Tail, male adult, 190; female immature, 202.

RANGE: Formosa.

The Formosan population is to some extent the end of a cline, for a tendency towards darker coloration is noticeable also in certain specimens from northern Burma and northern Indo-China, but not reaching quite the extreme shown by the two Formosan birds. The Formosan population seems to be rather isolated since the species has never been recorded in China, except in Yunnan.

THE RELATIONSHIPS OF *ACCIPITER TRIVIRGATUS*

There seems to be no close relative of this species except *A. griseiceps* from Celebes. The two species are obvious geographical representatives, as several authors have pointed out, and their immature plumages are almost indistinguishable (Van Marle and Voous, 1946). On the other hand, the adult plumages are strikingly different, and all the subspecies of *trivirgatus* are so similar to one another that it would seem unwise to include *griseiceps* in this species. However, both are obviously members of a single super-species.

The existence of *griseiceps*, as well as the presence of well-defined subspecies on the Sunda Islands and Philippines, as against only slight differences between the continental populations indicates that the species has been a resident of Sundaland for a long period. It probably reached the Philippines from Borneo (rather than from Palawan) and peninsular India via Burma-Assam. The populations of southern India and Ceylon have apparently become similar to those of Sumatra (and Nias) by convergence.

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